NOTES ON THE BIOLOGY OF *NEZUMIA SCLERORHYNCHUS* AND *NEZUMIA AEQUALIS* (GADIFORMES: MACROURIDAE) FROM THE ALGARVE SLOPE, NORTHEAST ATLANTIC

by

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ABSTRACT. - Some morphological features, bathymetric distribution and diet of *Nezumia sclerorhynchus* (Valenciennes, 1838) and *N. aequalis* (Günther, 1878) from the Portuguese south coast (Algarve slope) are described. Sagittae otoliths, the supraoccipital bone shape and other morphological features are described to help distinguishing juveniles of *N. sclerorhynchus* and *N. aequalis*. Collection depths of both species ranged from near 200 to 900 m. *N. sclerorhynchus* had its upper distribution limit at 500 m and *N. aequalis* at 600 m. From stomach contents analysis we conclude that the main prey for both species were amphipods, polychaetes and ophiurids. Secondary prey were isopods, mysids and copepods. Prey representing other systematic groups were part of the diet of *Nezumia* but insignificant in both number and weight.

RÉSUMÉ. - Notes sur la biologie de *Nezumia sclerorhynchus* et *Nezumia aequalis* (Gadiformes: Macrouridae) sur la pente de l'Algarve, Atlantique nord-est.

Des données sur la morphologie, la distribution bathymétrique et le régime alimentaire de *Nezumia sclerorhynchus* (Valenciennes, 1838) et de *N. aequalis* (Günther, 1878) sont fournies pour les populations de la côte sud du Portugal. La distribution bathymétrique de ces deux espèces est différente: *N. sclerorhynchus* a été trouvé entre 500 et 900 m et *N. aequalis* entre 600 et 900 m de profondeur. L'analyse des contenus stomacaux de ces deux espèces a révélé que les amphipodes, les polychètes et les ophiurides sont les proies principales. Les proies secondaires sont les isopodes, les mysidacés et les copépodes. La présence d'autres groupes de proies est aussi signalée, mais leur importance en nombre et en poids est insignifiante.

Key-words. - Macrouridae, *Nezumia sclerorhynchus*, *Nezumia aequalis*, ANE, ASE, Portuguese slope, Bathymetric distribution, Diet.

Many authors have described macrourid fishes as the dominant family of the benthopelagic fish fauna on the north-eastern Atlantic slope (Geistdoerfer, 1978; Gordon, 1986; Gordon and Mauchline, 1990; Merrett *et al.*, 1991a; 1991b; Haedrich and Merrett, 1992; Merrett, 1992). This situation holds true also along the south Portuguese coast (Algarve).

Nezumia sclerorhynchus was recorded for the first time in the Portuguese waters by Saldanha *et al.* (1995), when studying material from the Algarve slope. This species is dominant among all the macrourids from this area and can reach biomass values of 55 kg/km^2 (Figueiredo *et al.*, 1994).

Nezumia aequalis was recorded for the first time in Portuguese waters by Günther in 1878 under the name *Coryphaenoides aequalis*. This record was based on two individuals caught at 1092 m depth on the south Portuguese slope during the "Challenger" expedi-

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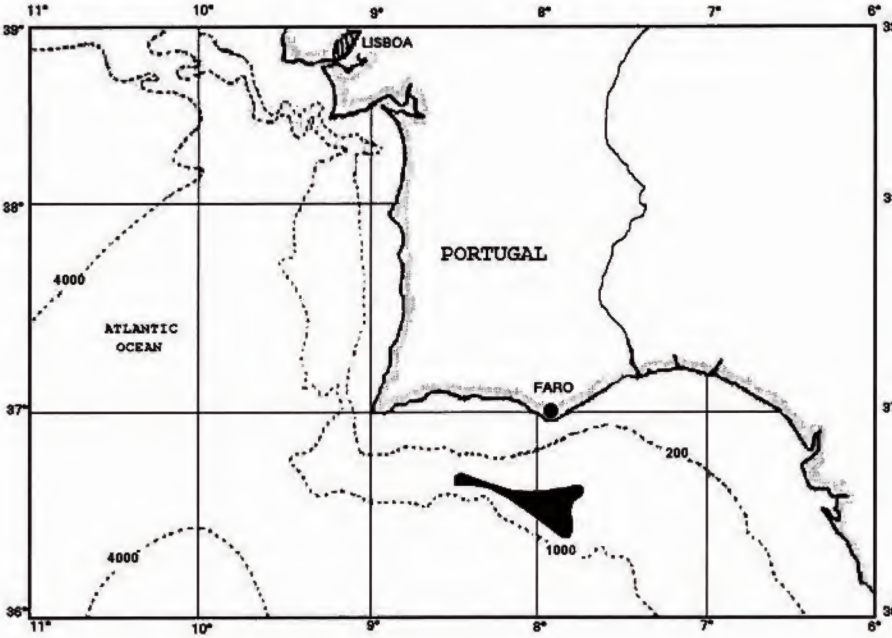

Fig. 1. - Algarve coast map showing the sampling area.

tion (Collett, 1896). Nobre (1935) and Albuquerque (1954-56) refer the same individuals. No other references have since been published for the species from Portuguese coast. Subsequently, the only record of *N. bairdii* (Goode & Bean, 1877) in the area, by Cascalho (1982), is perhaps a misidentification of *N. aequalis*.

The diet of *N. sclerorhynchus* from the Algarve slope, was fully described by Saldanha *et al.* (1995) from depths ranging between 519 and 732 m.

In the current work, some new morphological features are given to help distinguish juveniles of both species. Distribution and diet are also studied, from collections made at 500 to 900 m.

MATERIAL AND METHODS

Sampling took place on the Algarve slope from 200 to 900 m deep (Fig. 1) aboard the NI "Noruega" from IPIMAR (Deep-sea Resources Cruise Jan/95). A commercial otter trawl was used with a 35 mm mesh net. The mouth opening was 2.2 m high and 23 m wide. Towing lasted for 1 hour at approximately 1 knot speed.

From a total catch of 542 *Nezumia* specimens we took 304 individuals from stratified samples at every 100 m depth below 500 m. Consequently, a collection of samples was obtained from 517 m, 620 m, 700 m, 830 m, and 880 m. Specimens were frozen aboard ship.

The identification of the two species of *Nezumia* occurring in the Portuguese slope was accomplished based on meristic characters by Marshall and Iwamoto (1973) and Iwamoto (1990). To confirm identifications of small juveniles, the shape of the supraoccipital crest and the sagittae otolith are developed as diagnostic characters.

The stomach contents were washed in a Petri dish and food items were sorted into broad zoological categories using a binocular dissecting microscope. Wet weights of the food items, after removal of surface water by blotting on tissue paper, were obtained on a laboratory balance (precision 0.1 mg) and subsequently rounded to the nearest milligram. Prey identification to species level proved impossible due to the advanced degree of digestion of the stomach contents.

Hureau's Alimentary Coefficient, Q = Cn x Cp (Hureau, 1970), modified by Rosecchi, was used to assess relative importance of each food item on diet (where Cn - numerical percentage - is the total number of food items divided by the total number of all food items and Cp - weight percentage - is the total weight of food items divided by the total weight of all food items).

The Main Food Index - MFI - (Zander, 1982) was also calculated to rank prey preferences:

$$MFI = \sqrt{\frac{\%n + \%f}{2} \times \%W}$$

where n is the total number of prey items, f is the frequency of occurrence and W is the total weight of prey items.

To compare *Nezumia sclerorhynchus* and *N. aequalis* diets from the same depth, the Czekanowski's Quantitative Index, also known as the Bray-Curtis Index and Schoener Index (Mauchline and Gordon, 1984), was used:

$$S_{jk} = \frac{2\min(\chi_{ij} \cdot \chi_{ik})}{(\chi_{ij} + \chi_{ik})}$$

where χ_{ij} and χ_{ik} are the Cn values of comparable items in species j and k, the minimum values being summed. Indices are multiplied by 100 so that they range from 0 to 100 instead of from 0 to 1.

RESULTS

Morphology

Available dichotomous keys, for example the FAO Species Catalogue (Iwamoto, 1990) are sufficient to identify adults of *Nezumia sclerorhynchus* and *N. aequalis* but for smaller juveniles, described characteristics (under-side of snout scaled or not, scale spinules needle-like or brader, and 20 serrations on the 2nd dorsal spine) are difficult to use because i) at small size in both species the scales on the underside of the snout are very deciduous, ii) the 2nd spine of dorsal fin is often broken and iii) in the juvenile scales the spinules are almost alike. Therefore we describe three additional characters. The first character helps in field work, the other two are fitted to laboratory work (Table I).

The standard method to measure snout/1st dorsal spine length and distance orbit/vent is shown in figure 2, whose ratios separate the two species in accordance with table I.

Observations of the cranium in both species revealed different shapes of the supraoccipital crest (Fig. 3A, B). In *Nezumia aequalis* the superior edge of the crest is sloping while in *N. sclerorhynchus* it is horizontal. The sagittae of both species are also different (Fig. 3C, D): the ventral margin is linear in *Nezumia aequalis* and has an irregular outline in *N. sclerorhynchus*.

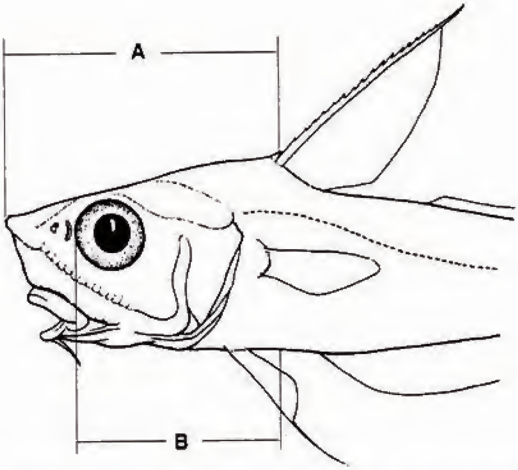

Fig. 2. - Morphological lengths needed to help identify *Nezumia sclerorhynchus* from *N. aequalis*. A: snouth/first dorsal spine length; B: orbit/anus lenght. Redrawn from Marshall and Iwamoto, 1973.

Bathymetric distribution

Bathymetric distributions of both species overlap below 600 m with *Nezumia sclerorhynchus* relatively more abundant (1/65 ratio in the catches at that depth). Below 800 m the ratio increases to 1/2.

Size classes/depth analysis shows that adults of *Nezumia sclerorhynchus*, considered as adults those with 30 to 40 mm head length (Merrett and Marshall, 1981), are centred in depths around 700 and 880 m (Fig. 4). Juveniles (size class 17-23 mm) inhabit shallower levels (517-700 m), and sub-adults (size class 23-29 mm) are mostly present at 700 m depth. However, all size classes are present in every studied depth.

N. aequalis juveniles (size class 17-23 mm) were not caught at any depth sampled (Fig. 4).

Diet

At different depth strata the mean prey weight and mean prey number for *Nezumia sclerorhynchus* differ (Table II). At 700 m the high mean prey number for each stomach examined is due to an increased consumption of isopods and mysids (Fig. 5). Because larger individuals are strongly represented at 830 m deep (Fig. 4), the high mean prey weight observed for each stomach is expected and results from these individuals ability to

Table I. - Different features in both species that can help to identify them correctly. The first step helps in field work, the other two are fitted to laboratory work.

	Nezumia sclerorhynchus	*Nezumia aequalis*
Snout / 1st dorsal spine length	Equal to length from anteriormost part of orbital bone to anus (Fig. 2).	Larger than the length from anteriormost part of orbital bone to anus (Fig. 2).
Supraoccipital bone	Points up (Fig. 3B).	Points horizontally (Fig. 3A).
Sagitta ventral margin	Linear (Fig. 4B)	Irregular (Fig. 4A)

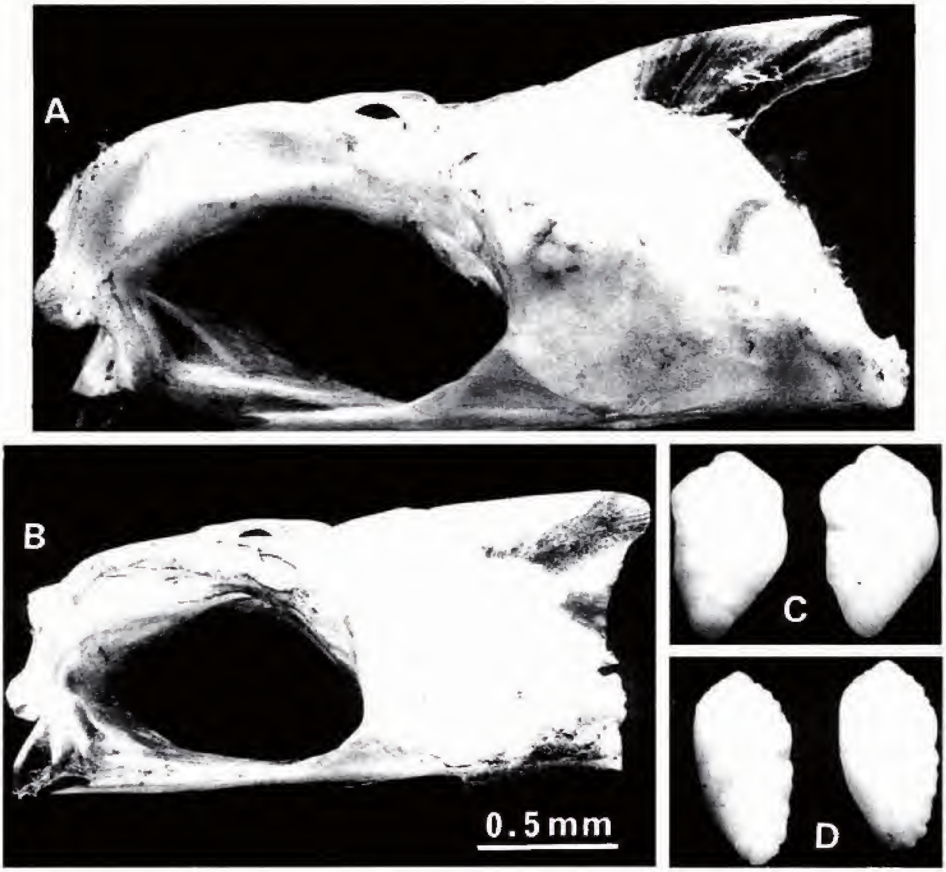

Fig. 3. - Shape of the supraoccipital crest of *Nezumia aequalis* (A) and *N. sclerorhynchus* (B), and their sagittae otoliths (C) and (D) respectively.

eat larger prey, such as little shrimps, stomatopods, and even some larger amphipods. At 517 m deep, the value of the mean prey weight (Table II) is due to the high frequency of occurrence of ophiurids (Fig. 5) and a bias introduced by the shell weight of a gastropod.

Using the two described indexes, Hureau's and MFI, we achieve the prey classification shown in table III. The prey classification varies according the index used. This

Table II. - Quantitative results of stomach contents analysis by depth in *Nezumia sclerorhynchus*.

Depths (m)	Mean prey weight (mg)	Mean prey number
517	70.1	4.7
620	36.7	4.1
700	38.2	9.7
830	112.4	4.1
880	21.4	7.6

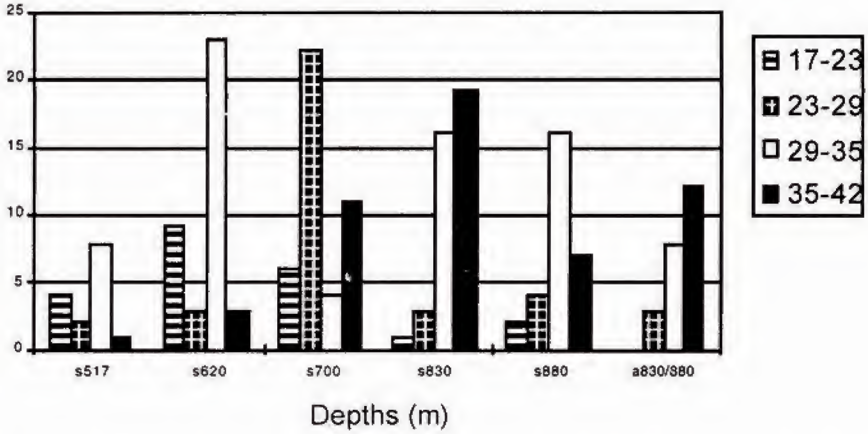

Fig. 4. - Head length (mm) classes distribution. *Nezumia aequalis* samples (a830 and a880) were pooled together. a: *N. aequalis*; s: *N. sclerorhynchus*.

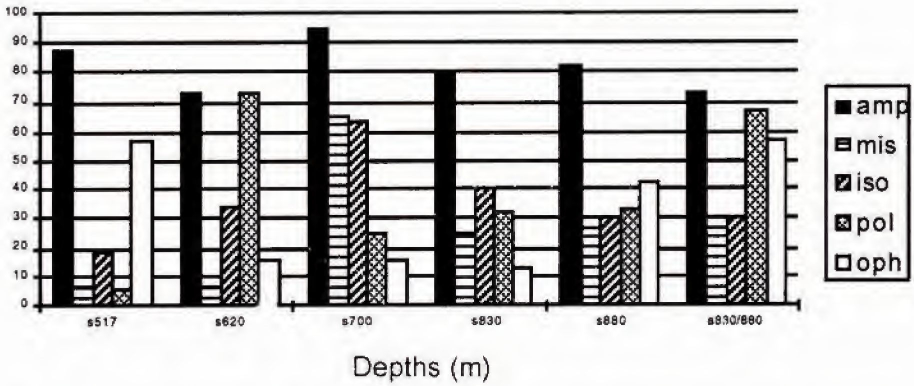

Fig. 5. - Main prey frequencies at each studied depth. a: *N. aequalis*; s: *N. sclerorhynchus*. amp.: Amphipoda; iso.: Isopoda; mis.: Mysidacea; oph.: Ophiuridae; pol.: Polychaeta.

slight variation is due to an intrinsic characteristic of the MFI index, which gives more importance to f (frequency of prey occurrence) than does the Hureau's Alimentary Coefficient (Q). Nevertheless, both indexes indicate that *N. sclerorhynchus* and *N. aequalis* are generalist feeders because of i) the presence of few taxa as "Principal prey" (MFI index) and even its total absence at some depths; ii) the Q index classification that includes more than one "main preferred prey". Both indexes, however, always classify amphipods as an important prey for both species at every studied depth. The highest consumption levels of isopods and mysids are at 700 m for *N. sclerorhynchus* (Fig. 5). In contrast, polychaetes and ophiurids, as well as amphipods are the most important prey items for *N. aequalis*.

Comparison of the diet of *N. sclerorhynchus* with that of *N. aequalis* at 830-880 m deep, using the Bray-Curtis similarity index, gave a value of 0.64. In terms of percentage, it means that 64% of the diet of the two species are similar. We believe that the remaining 36% non-similar is linked to the consumption of ophiurids by *N. aequalis*.

DISCUSSION - CONCLUSIONS

Nezumia sclerorhynchus is closely related to *N. aequalis*. The two species overlap in their distribution off the Portuguese south coast. Relying on the relative abundance observed in our hauls, *N. sclerorhynchus* is the more common of the two species. Its bathymetric distribution ranged from 517 to 880 m, and it was most numerous in catches in depths of 620 to 880 m (maximum depth trawled). Iwamoto (1990) detailed the occurrence of *N. sclerorhynchus* in the North Atlantic but did not establish the northern distributional limit. Haedrich and Merrett (1988) also did not record this species northerly than Morocco, in the North Atlantic Basin. Gordon and Mauchline (1990) and Merrett *et al.* (1991b) did not record the species for the Rockall Trough and from the Porcupine Seabight, respectively. Saldanha *et al.* (1995) recorded the first occurrence of this species in Portuguese waters (Algarve). The northern distribution limit of *N. sclerorhynchus* is not yet clarified although we procured some individuals from an 1994 IPIMAR "Demersal Cruise" off the north coast of Portugal (off Porto - Lat. 41°N).

Iwamoto (1990) stated that *N. aequalis* occurs from "Faroë Bank to northern Angola and the Mediterranean Sea." Haedrich and Merrett (1988) did not have any information on the species from Portuguese coast. These authors present a figure concerning vertical and horizontal distribution of *N. aequalis*, with records from the West African coast, off Morocco, the Porcupine Seabigth, and the Rockall Trough, but none covering the gap between the African coast and the Porcupine Seabight. Also, in the faunal lists of the Instituto Nacional de Investigação das Pescas (INIP) Cruises (INIP, 1986; 1990a; 1990b) only record *N. sclerorhynchus*. An occurrence of *N. bairdii* (Cascalho, 1982) still remains to be confirmed but this possibly was a misidentification of *N. aequalis*.

Macrourid diet have been studied widely, and the general conclusion is that such species are benthopelagic generalist feeders. Crustaceans and polychaetes have been reported as the main observed prey (Marshall and Merrett, 1977; McLellan, 1977; Geistdoerfer, 1978; Gordon and Duncan, 1987; Saldanha *et al.*, 1995), which agrees with our results. Some exceptions are *Bathygadus, Gadomus, Hymenocephalus, Nezumia condylura, Odontomacrourus murrayi*, and even large specimens of *Coryphaenoides armatus* and *C. rupestris*, which were found to feed on pelagic hyperiid amphipods (McLellan, 1977). Among crustaceans, amphipods are the main preferred prey. In the *N. sclerorhynchus* diet at 700 m deep, the increase of isopods and mysids and the decrease of polychaetes and ophiurids suggest that i) a prey patchiness may exist, or ii) isopods and mysidaceans are preferred prey for sub-adults, which are the most abundant size class (23-29) at this depth.

Table III. - Prey classification at different depths for *Nezumia aequalis* (a) and *N. sclerorhynchus* (s). amp.: Amphipoda; mis.: Mysidacea; oph.: Ophiuridae; pol.: Polychaeta.

Depth (m)	Main preferred prey $Q > 100$ and $f > 0.3$	Principal prey $75 < MFI > 50$	Secondary prey $MFI < 50$
s 517	amp., pol., oph.		amp.
s 620	amp., pol.	pol.	amp.
s 700	amp., mis., iso.	amp.	iso.
s 830	amp.		amp.
s 880	amp.	amp.	
a 830/880	amp., pol.		amp., pol., oph.

In spite of the Bray-Curtis similarity index, calculated for *N. sclerorhynchus* and *N. aequalis* diets at the same depth, that concluded that 64% of their diet is alike, we believe that predation by *N. aequalis* on the endobenthic and epibenthic fauna (polychaetes and ophiurids) is more intense than it is by *N. sclerorhynchus*.

Acknowledgements. - This work was supported by the Contract MAS 2 CT 920033 "Community structure and processes in the deep-sea benthos." The authors are indebted to Prof. Luiz Saldanha for his guidance, scientific advices and critical reading of the manuscript. Also thanks to IPIMAR for making available the R/V "Noruega," to all the ship's crew, and to our colleague Ana Colaço who was very helpful during the field work.

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Reçu le 02.03.1997.
Accepté pour publication le 22.09.1997.